

Exhibit 4

Samsung – Smartphones and Tablets (models with IR cameras, models having cameras with IR sensitivity, and models with the Iris Scan feature. See Product List at end for models)

Infringement of the '413 patent

Claim 1	Evidence																														
1. A mobile communication device comprising a computational means and output means,	<p>The Samsung smartphone is a mobile communication device that has a computational means and an output means.</p> <p>For example, the smartphone is a communication that includes a system-on-chip (SoC) device, which includes a main processor as a computational device, and a touchscreen, which is an output device.</p> <p>For example the Galaxy S4 includes a Qualcomm Snapdragon SoC CPU device and an AM-OLED touchscreen display:</p> <table border="1"> <tbody> <tr> <td>Brand</td> <td>Samsung</td> </tr> <tr> <td>Model</td> <td>SM-T837T Galaxy Tab S4 10.5 2018 LTE-A US 64GB</td> </tr> <tr> <td>Brief</td> <td>T-Mobile USA variant</td> </tr> <tr> <td>Released</td> <td>2018 Sep 24</td> </tr> <tr> <td>Announced</td> <td>2018 Aug 29</td> </tr> <tr> <td>Hardware Designer</td> <td>Samsung Electronics</td> </tr> <tr> <td>Manufacturer</td> <td>Samsung Electronics [6]</td> </tr> <tr> <td colspan="2">Application processor, Chipset:</td> </tr> <tr> <td>CPU Clock</td> <td>2350 MHz</td> </tr> <tr> <td>CPU</td> <td>Qualcomm Snapdragon 835 MSM8998, 2017, 64 bit, octa-core, 32 Kbyte I-Cache, 32 Kbyte D-Cache, 2048 Kbyte L2, 10 nm, Qualcomm Adreno 540 GPU</td> </tr> <tr> <td colspan="2">Operative Memory:</td> </tr> <tr> <td>RAM Type</td> <td>mobile (LP) DDR4 SDRAM</td> </tr> <tr> <td></td> <td>1866 MHz</td> </tr> <tr> <td>RAM Capacity</td> <td>4096 MiB RAM</td> </tr> <tr> <td></td> <td>3321 MiB user accessible RAM [6]</td> </tr> </tbody> </table>	Brand	Samsung	Model	SM-T837T Galaxy Tab S4 10.5 2018 LTE-A US 64GB	Brief	T-Mobile USA variant	Released	2018 Sep 24	Announced	2018 Aug 29	Hardware Designer	Samsung Electronics	Manufacturer	Samsung Electronics [6]	Application processor, Chipset:		CPU Clock	2350 MHz	CPU	Qualcomm Snapdragon 835 MSM8998, 2017, 64 bit, octa-core, 32 Kbyte I-Cache, 32 Kbyte D-Cache, 2048 Kbyte L2, 10 nm, Qualcomm Adreno 540 GPU	Operative Memory:		RAM Type	mobile (LP) DDR4 SDRAM		1866 MHz	RAM Capacity	4096 MiB RAM		3321 MiB user accessible RAM [6]
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[7]

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Brand ⓘ	Samsung
Model ⓘ	SM-G965U1 Galaxy S9+ TD-LTE US
Released ⓘ	2018 Mar 16
Announced ⓘ	2018 Feb 25
Hardware Designer ⓘ	Samsung Electronics
Manufacturer ⓘ	Samsung Electronics [8]
# Application processor, Chipset:	
CPU Clock ⓘ	2800 MHz
CPU ⓘ	Qualcomm Snapdragon 845 SDM845 (Napali), 2018, 64 bit, octa-core, 32 Kbyte I-Cache, 32 Kbyte D-Cache, 1536 Kbyte L2, 2048 Kbyte L3, 10 nm, Qualcomm Adreno 630 GPU ⓘ
# Operative Memory:	
RAM Type ⓘ	LPDDR4x SDRAM
	1866 MHz ⓘ
RAM Capacity (converted) ⓘ	6 GiB RAM
[8]	

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Further comprising a module incorporating a non-contact temperature sensor for receiving from an external surface electromagnetic radiation in the infrared spectral range,	<p>The Samsung smartphone further includes a module incorporating a non-contact temperature sensor for receiving from an external surface electromagnetic radiation in the infrared spectral range.</p> <p>For example, the Galaxy S4 and Note 3 models have an IR sensor, which is a smartphone module that is capable of sensing infrared electromagnetic radiation from an external source in a non-contact manner, thereby being operational as a non-contact temperature sensor.</p>																				

Smartphones with thermometers do exist

The idea is nothing new and manufacturers in their constant pursuit of innovation did give it a try. Namely, Samsung and Motorola had phones with thermometers once. Samsung did it with the Galaxy S4 and Note 3. According to the instructions for using this feature, measuring the temperature required you to leave the device to cool off from any heat it might have accumulated during use and leave it somewhere so it doesn't get warm from your hands.

[1]

For example, the Galaxy S21 Plus smartphone includes an IR camera, which is a smartphone module that is capable of sensing infrared electromagnetic radiation from an external source in a non-contact manner, thereby being operational as a non-contact temperature sensor.



Samsung Galaxy S21 Plus - Wide Camera Modified for Near Infrared Sensitivity

[2]

For example, the IR camera of the Galaxy S8, S8+, S9, S9+ and Note 8 models is used for the Iris Scan feature, whereby infrared radiation which inherently includes temperature information, reflected by a user's eyes is used to distinguish unique characteristics of the user's eyes.

Why do we use IR(Infrared Ray)? or Iris Scan in Samsung Galaxy S8+?

Last Update date : Oct 30. 2020

In the case of visible ray, Iris pattern can be easily interfered by the reflection from other stray visible light UV light is strong enough to sterilize so that it may ingenerate skin aging. For those reasons, iris scan technology uses safer IR.



[3]

With Iris Scanning, your Samsung Galaxy illuminates your eyes with an IR-LED and snaps an IR photograph. Then, your phone looks at the details of your eyes and compares them to previous pictures. If the phone can verify who you are, then it unlocks.



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[4]

What is iris scanning and how to use it on Galaxy device

Last Update date : Jul 26, 2022

The iris recognition feature uses the unique characteristics of your irises, such as their shape and pattern, to strengthen the security of your device. Your iris data can be used for various authentication purposes.

Note: Device screenshots and menus may vary depending on the device model and software version.

Tips for using IRIS scanner



- Hold your device about 25-35 cm away from your face with the screen facing towards you. Position your eyes in the circles shown on the screen.
Wearing glasses or contacts when unlocking your device or verifying your identity may cause the device to have difficulty recognizing your irises.
- Keep your eyes open and look at the top of the screen.
- IRIS recognition may not work properly in direct sunlight. For best results, perform this process indoors.
- Dirt and debris on the IRIS camera, LED sensor, or proximity sensor may cause the device to have difficulty recognizing your irises.

[5]

such non-contact temperature sensor generates a signal.

The non-contact temperature sensor of the Samsung smartphone generates a signal.
For example the IR sensor in the Galaxy S4 and Note 3 models worked as a non-contact temperature sensor to enable a user to take an ambient temperature reading. The IR sensor produces a signal that is used by the SoC processor to provide a numeric temperature reading to the user via the

display.

Smartphones with thermometers do exist

The idea is nothing new and manufacturers in their constant pursuit of innovation did give it a try. Namely, Samsung and Motorola had phones with thermometers once. Samsung did it with the Galaxy S4 and Note 3. According to the instructions for using this feature, measuring the temperature required you to leave the device to cool off from any heat it might have accumulated during use and leave it somewhere so it doesn't get warm from your hands.

[1]

For example the IR camera in the Galaxy S21 Plus model generates an IR image signal that inherently includes temperature information, e.g. hotter objects appear brighter in the image, which enables a user to distinguish hot objects from colder objects, bare earth from vegetation etc.



Samsung Galaxy S21 Plus - Wide Camera Modified for Near Infrared Sensitivity

[2]

For example, the IR camera of the Galaxy S8, S8+, S9, S9+ and Note 8 models used for the Iris Scan feature generates an image signal responsive to the infrared radiation received from the user's iris and compares that image to previous images of the user's iris. If the images match sufficiently, the SoC unlocks the smartphone.

IR Scanning is Very Simple

Iris Scanner and Face ID are forms of biometric identification, and they're both used to unlock your phone and to open sensitive apps (banking apps, for example). Both processes are similar and easy to understand. New Apple and Samsung's phones are equipped with an IR-LED that emits near IR light, and an IR camera that is capable of capturing IR light.

With Iris Scanning, your Samsung Galaxy illuminates your eyes with an IR-LED and snaps an IR photograph. Then, your phone looks at the details of your eyes and compares them to previous pictures. If the phone can verify who you are, then it unlocks.



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Samsung – Smartphones and Tablets (models with the Iris Scan feature. See Product List at end for models)

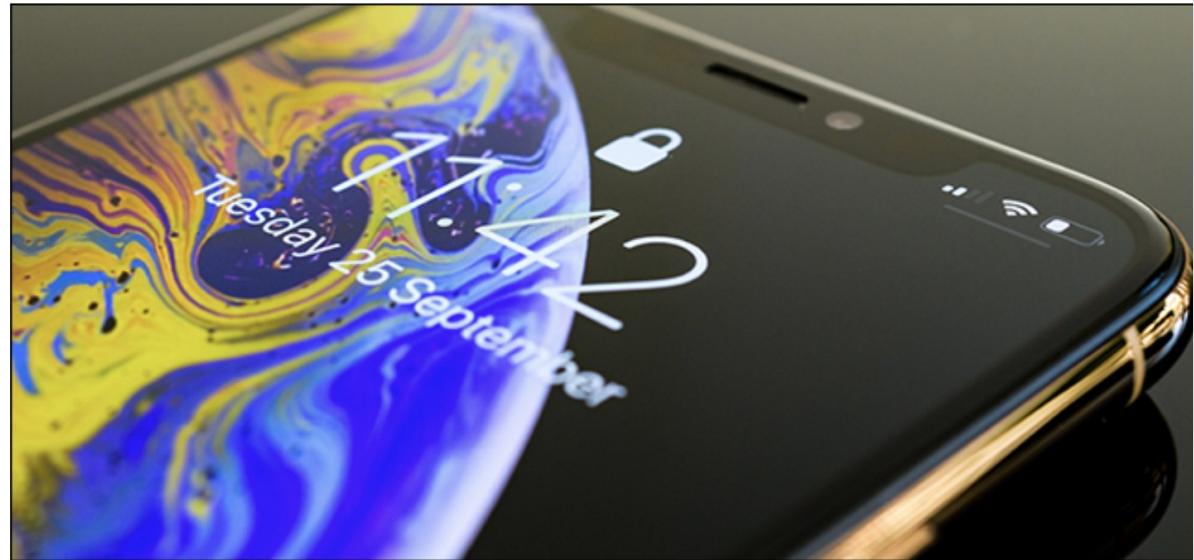
Infringement of the '413 patent

Claim 6	Evidence
6. The mobile communication device of claim 1, wherein said external surface is part of a head of a human.	<p>The Samsung smartphone is capable of receiving electromagnetic radiation from an external surface, wherein the external surface is part of a head of a human.</p> <p>For example, the Galaxy S8, S8+, S9, S9+ and Note 8 models have an Iris Scan feature that receives electromagnetic radiation from a human eye, which is part of a human head.</p>

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Iris Scanner and Face ID are forms of biometric identification, and they're both used to unlock your phone and to open sensitive apps (banking apps, for example). Both processes are similar and easy to understand. New Apple and Samsung's phones are equipped with an IR-LED that emits near IR light, and an IR camera that is capable of capturing IR light.

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Samsung - Smartphones and Tablets (models with IR cameras, models having cameras with IR sensitivity, and models with the Iris Scan feature. See Product List at end for models)

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8. A mobile communication device comprising a computational means and output means, further comprising:	<p>The Samsung smartphone is a mobile communication device that has a computational means and an output means.</p> <p>For example, the smartphone is a communication that includes a system-on-chip (SoC) device, which includes a main processor as a computational device, and a touchscreen, which is an output device.</p> <p>For example the Galaxy S4 includes a Qualcomm Snapdragon SoC CPU device and an AM-OLED touchscreen display:</p> <table border="1"> <tbody> <tr> <td>Brand ⓘ</td><td>Samsung</td></tr> <tr> <td>Model ⓘ</td><td>SM-T837T Galaxy Tab S4 10.5 2018 LTE-A US 64GB</td></tr> <tr> <td>Brief ⓘ</td><td>T-Mobile USA variant</td></tr> <tr> <td>Released ⓘ</td><td>2018 Sep 24</td></tr> <tr> <td>Announced ⓘ</td><td>2018 Aug 29</td></tr> <tr> <td>Hardware Designer ⓘ</td><td>Samsung Electronics</td></tr> <tr> <td>Manufacturer ⓘ</td><td>Samsung Electronics [6]</td></tr> <tr> <td colspan="2">Application processor, Chipset:</td></tr> <tr> <td>CPU Clock ⓘ</td><td>2350 MHz</td></tr> <tr> <td>CPU ⓘ</td><td>Qualcomm Snapdragon 835 MSM8998, 2017, 64 bit, octa-core, 32 Kbyte I-Cache, 32 Kbyte D-Cache, 2048 Kbyte L2, 10 nm, Qualcomm Adreno 540 GPU ⓘ</td></tr> <tr> <td colspan="2">Operative Memory:</td></tr> <tr> <td>RAM Type ⓘ</td><td>mobile (LP) DDR4 SDRAM</td></tr> <tr> <td></td><td>1866 MHz ⓘ</td></tr> <tr> <td>RAM Capacity ⓘ</td><td>4096 MiB RAM</td></tr> <tr> <td></td><td>3321 MiB user accessible RAM ⓘ</td></tr> </tbody> </table> <p>[6]</p>	Brand ⓘ	Samsung	Model ⓘ	SM-T837T Galaxy Tab S4 10.5 2018 LTE-A US 64GB	Brief ⓘ	T-Mobile USA variant	Released ⓘ	2018 Sep 24	Announced ⓘ	2018 Aug 29	Hardware Designer ⓘ	Samsung Electronics	Manufacturer ⓘ	Samsung Electronics [6]	Application processor, Chipset:		CPU Clock ⓘ	2350 MHz	CPU ⓘ	Qualcomm Snapdragon 835 MSM8998, 2017, 64 bit, octa-core, 32 Kbyte I-Cache, 32 Kbyte D-Cache, 2048 Kbyte L2, 10 nm, Qualcomm Adreno 540 GPU ⓘ	Operative Memory:		RAM Type ⓘ	mobile (LP) DDR4 SDRAM		1866 MHz ⓘ	RAM Capacity ⓘ	4096 MiB RAM		3321 MiB user accessible RAM ⓘ
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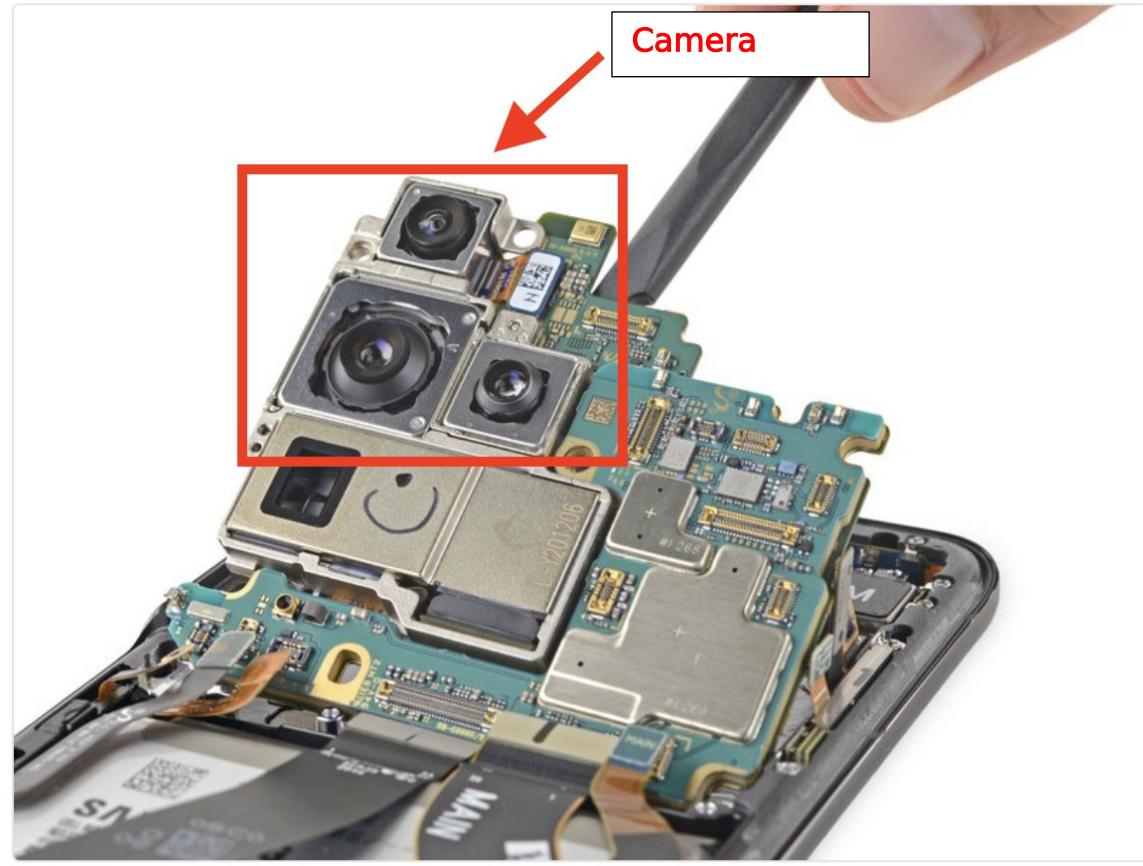
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Released ⓘ	2018 Mar 16
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Hardware Designer ⓘ	Samsung Electronics ⓘ
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⌘ Operative Memory:	
RAM Type ⓘ	LPDDR4x SDRAM
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RAM Capacity (converted) ⓘ	6 GiB RAM
[8]	

	<p>❖ Display</p> <table border="1"> <tbody> <tr> <td>Display Diagonal</td><td>158.1 mm 6.2 inch</td></tr> <tr> <td>Resolution</td><td>1440x2960</td></tr> <tr> <td>Horizontal Full Bezel</td><td>4.64 mm</td></tr> <tr> <td>Width</td><td></td></tr> <tr> <td>Display Area Utilization</td><td>84.3%</td></tr> <tr> <td>Pixel Density</td><td>529 PPI</td></tr> <tr> <td>Display Type</td><td>AM-OLED display</td></tr> <tr> <td>Display Subtype</td><td>Super AM-OLED</td></tr> <tr> <td>Number of Display Scales</td><td>16.8M</td></tr> <tr> <td>Scratch Resistant Screen</td><td>Gorilla Glass 5</td></tr> </tbody> </table>	Display Diagonal	158.1 mm 6.2 inch	Resolution	1440x2960	Horizontal Full Bezel	4.64 mm	Width		Display Area Utilization	84.3%	Pixel Density	529 PPI	Display Type	AM-OLED display	Display Subtype	Super AM-OLED	Number of Display Scales	16.8M	Scratch Resistant Screen	Gorilla Glass 5
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a module for receiving and measuring a magnitude of electromagnetic radiation, wherein said electromagnetic radiation is generated by a source that is not being part of the mobile communication device,	<p>[8]</p> <p>The Samsung smartphone further includes a module for receiving and measuring a magnitude of electromagnetic radiation, wherein the electromagnetic radiation is generated by a source that is not part of the mobile communication device.</p> <p>For example, the central module of the smartphone (e.g. Samsung Galaxy S21) is a module to which the Qualcomm Snapdragon SoC device and touchscreen are communicatively coupled during manufacturing of the smartphone. The main board of the smartphone includes an IR camera (or IR sensor), which is capable of sensing and measuring infrared electromagnetic radiation from a source that is not part of the smartphone.</p>																				

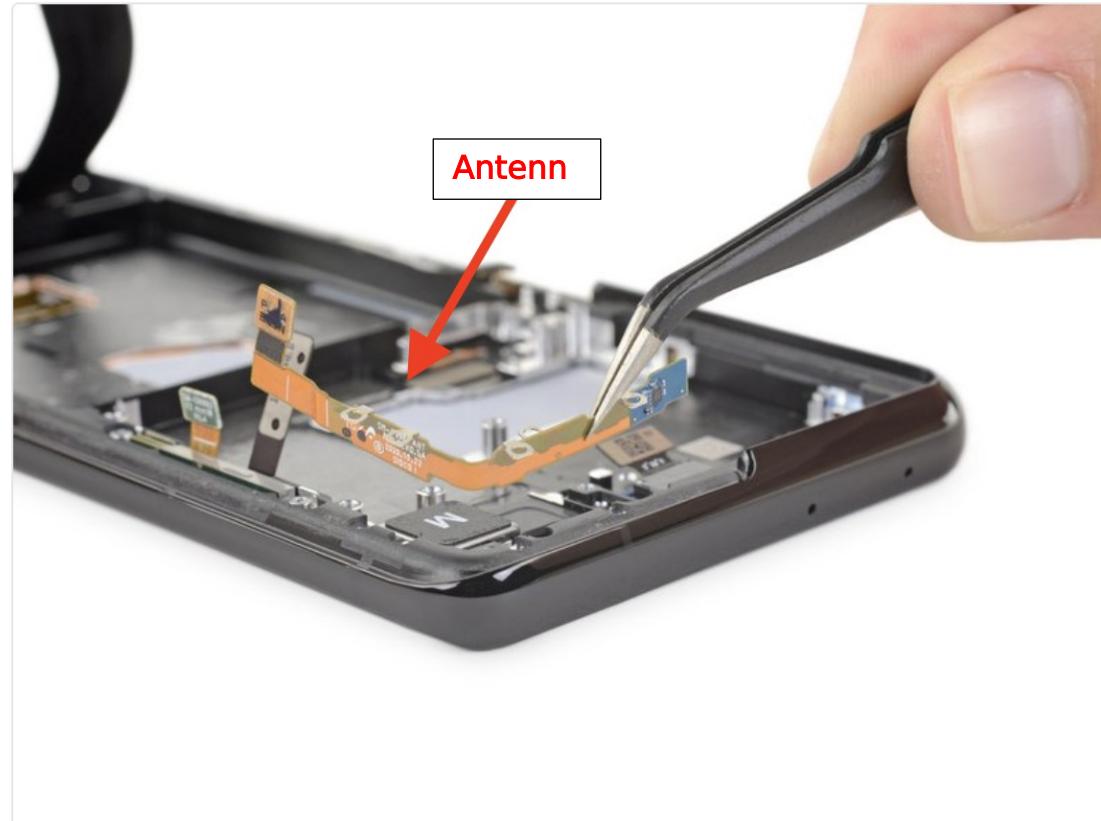
Step 6



[9]

	<p>Step 7</p> <ul style="list-style-type: none"> ● Do these boards look like howling dogs? Anyways, let's check out what makes this phone tick: <div style="border: 2px solid red; padding: 5px; margin-left: 20px;"> <ul style="list-style-type: none"> ● Qualcomm Snapdragon 888 layered beneath Samsung K3LK4K40CM-BGCP 12 GB LPDDR5 RAM </div> <ul style="list-style-type: none"> ● Samsung flash storage KLUDG4UHDC-B0E1 128 GB ● Qualcomm SMR526 5G modulator ● Maxim MAX77705C power management IC ● Qualcomm QPM5825 power management IC ● Qualcomm QDM5872 and QDM4820 Front-End Module ● Cirrus Logic CS35L40 audio amplifier IC
[9]	<p>and such module comprising at least one antenna adapted for operation in the radio frequency range.</p> <p>The Samsung the module of the smartphone includes at least one antenna adapted for operation in the radio frequency range.</p> <p>For example, the central module includes an RF antenna for cellular communications by the smartphone. The RF antenna is positioned at one corner of the central module.</p>

Step 12



[9]

Samsung – Smartphones and Tablets (models with IR cameras, models having cameras with IR sensitivity, and models with the Iris Scan feature. See Product List at end for models)

Infringement of the '413 patent

Claim 9	Evidence
9. A method of measuring the magnitude of electromagnetic radiation in a selected location by a mobile communication device, consisting of the steps of:	<p>The Samsung smartphone performs a method of measuring the magnitude of electromagnetic radiation in a selected location.</p> <p>For example, when the IR sensor is used for temperature sensing, or the IR camera is used to take an IR image (e.g. as in a scenic photo or for the Iris Scan feature) the smartphone measures the magnitude of infrared electromagnetic radiation received by the smartphone's IR camera (or IR sensor) from the location at which the IR camera/sensor is aimed.</p> <p>For example, the Galaxy S4 and Note 3 models have an IR sensor, which is a smartphone/tablet module that is capable of measuring the magnitude of infrared electromagnetic radiation from an external source.</p> <p style="text-align: center;">Smartphones with thermometers do exist</p> <p>The idea is nothing new and manufacturers in their constant pursuit of innovation did give it a try. Namely, Samsung and Motorola had phones with thermometers once. Samsung did it with the Galaxy S4 and Note 3. According to the instructions for using this feature, measuring the temperature required you to leave the device to cool off from any heat it might have accumulated during use and leave it somewhere so it doesn't get warm from your hands.</p> <p style="text-align: right;">[1]</p> <p>For example, the Galaxy S21 Plus smartphone includes an IR camera, which</p>

is a smartphone module that is capable of measuring the magnitude of infrared electromagnetic radiation from a location at which the camera is aimed.



Samsung Galaxy S21 Plus - Wide Camera Modified for Near Infrared Sensitivity

[2]

For example, the IR camera of the Galaxy S8, S8+, S9, S9+ and Note 8 models is used for the Iris Scan feature, whereby the IR camera measures the magnitude of infrared radiation reflected by a user's eyes, a location at which the camera is aimed, to distinguish unique characteristics of the user's eyes.

Why do we use IR(Infrared Ray)? or Iris Scan in Samsung Galaxy S8+?

Last Update date : Oct 30. 2020

In the case of visible ray, Iris pattern can be easily interfered by the reflection from other stray visible light **UV light** is strong enough to sterilize so that it may ingenerate skin aging. For those reasons, iris scan technology uses safer IR.



[3]

	<p>With Iris Scanning, your Samsung Galaxy illuminates your eyes with an IR-LED and snaps an IR photograph. Then, your phone looks at the details of your eyes and compares them to previous pictures. If the phone can verify who you are, then it unlocks.</p>  <p><small>© Hadrian/Shutterstock</small></p>
[4] providing a mobile communication device that comprises a housing, a digital imaging sensor having a first field of view, such sensor is for generating a digital image of the selected location,	<p>The Samsung smartphone further provides a mobile communication device that comprises a housing and a digital imaging sensor having a first field of view. The sensor is for generating a digital image of the selected location.</p> <p>For example, the smartphone includes a housing for enclosing a digital image sensor, among other components of the smartphone. The digital image sensor has a field of view (e.g. outwards from the rear of the smartphone) and is for generating a digital image of a subject or location at which it is aimed.</p>

For example the Galaxy S4 has 13.1 MP CMOS image sensor within a housing.

**Samsung SM-T837T Galaxy Tab S4 10.5
2018 LTE-A US 64GB (Samsung T830)
Detailed Tech Specs**



[6]

Primary Camera System

Camera Placement	Rear
Camera Module	Samsung S5K3L8
Camera Image Sensor	<u>CMOS</u>
Image Sensor Format	1/3.06
Image Sensor Pixel Size	1.12 micrometer
Camera Resolution	4208x3120 pixel
Number of effective pixels	<u>13.1 MP camera</u>

[6]

For example, the Galaxy S21 has 12MP BSI CMOS image sensor within a housing.

Samsung SM-G990U1 Galaxy S21 FE 5G
UW TD-LTE US 128GB (Samsung G990)
Detailed Tech Specs



[7]

[7]

Primary Camera System ⓘ

Camera Placement Rear ⓘ

ⓘ

Camera Module ⓘ Samsung ISOCELL Plus S5K2LD

Camera Image BSI CMOS ⓘ

Sensor ⓘ

Image Sensor 1/1.76

Format ⓘ

Image Sensor Pixel 1.80 micrometer

Size ⓘ

Camera Resolution 4000x3000 pixel

ⓘ

Number of 12.0 MP camera
effective pixels ⓘ

[7]

[7]

For example, the Galaxy S9+ has a 12.2 MP BSI CMOS image sensor within a housing.

	<p>Samsung SM-G965U1 Galaxy S9+ TD-LTE US (Samsung Star 2)</p>  <p>[8]</p> <p>Primary Camera System</p> <p>Camera Placement Rear</p> <p>Camera Image Sensor BSI CMOS</p> <p>Image Sensor Pixel Size 1.40 micrometer</p> <p>Number of effective pixels 12.2 MP camera</p> <p>Aperture (W) f/1.50</p> <p>Aperture (T) f/2.40</p> <p>Zoom 1.0 x optical zoom 8.0 x digital zoom</p>
a computational means,	The Samsung smartphone further provides a computational means.

For example, the SoC CPU device includes a main processor for performing computational processing.

For example the Galaxy S4 includes a Qualcomm Snapdragon SoC CPU device:

Brand	Samsung
Model	SM-T837T Galaxy Tab S4 10.5 2018 LTE-A US 64GB
Brief	T-Mobile USA variant
Released	2018 Sep 24
Announced	2018 Aug 29
Hardware Designer	Samsung Electronics
Manufacturer	Samsung Electronics [6]
Application processor, Chipset:	
CPU Clock	2350 MHz
CPU	Qualcomm Snapdragon 835 MSM8998, 2017, 64 bit, octa-core, 32 Kbyte I-Cache, 32 Kbyte D-Cache, 2048 Kbyte L2, 10 nm, Qualcomm Adreno 540 GPU [6]
Operative Memory:	
RAM Type	mobile (LP) DDR4 SDRAM
	1866 MHz [6]
RAM Capacity	4096 MiB RAM
	3321 MiB user accessible RAM [6]

For example, the Galaxy includes a Qualcomm Snapdragon SoC CPU device:

Brand	Samsung
Model	SM-G990U1 Galaxy S21 FE 5G UW TD-LTE US 128GB
Brief	Photography amateurs and pros-alike can effortlessly edit, post, and share scroll-stopping content. Unlocked single SIM variant of Galaxy S21 FE 5G UW for the US
Released	2022 Jan 4
Announced	2022 Jan 3
Hardware Designer	Samsung Electronics [6]
Manufacturer	Samsung Electronics [7]

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[8]													
and an output means for	The Samsung smartphone further provides an output means for conveying												

conveying information to an operator;

information to an operator.

For example, the smartphone also includes a touchscreen display for conveying information to an operator.

For example the Galaxy S4 includes an AM-OLED touchscreen display:

Brand ⓘ	Samsung
Model ⓘ	SM-T837T Galaxy Tab S4 10.5 2018 LTE-A US 64GB
Brief ⓘ	T-Mobile USA variant
Released ⓘ	2018 Sep 24
Announced ⓘ	2018 Aug 29
Hardware Designer ⓘ	Samsung Electronics
Manufacturer ⓘ	Samsung Electronics

[6]

❖ Display	
Display Diagonal	266.2 mm 10.5 inch
Resolution	1600x2560 4096000 pixels
Display Width	141.09 mm 5.55 inch
Display Height	225.74 mm 8.89 inch
Horizontal Full Bezel Width	108.21 mm
Display Area	31848.3 square millimeter
Display Area Utilization	77.8%
Pixel Size	0.08818 mm/pixel
Pixel Density	288 PPI
Display Type	Color AM-OLED display
Display Subtype	Super AM-OLED
Display Color Depth	24 bit/pixel
Number of Display Scales	16.8M
	[6]
For example, the Galaxy S21 includes an AM-OLED touchscreen display:	
Brand	Samsung
Model	SM-G990U1 Galaxy S21 FE 5G UW TD-LTE US 128GB
Brief	Photography amateurs and pros-alike can effortlessly edit, post, and share scroll-stopping content. Unlocked single SIM variant of Galaxy S21 FE 5G UW for the US
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incorporating into the housing a module that is responsive to intensity of the electromagnetic radiation in a selected spectral range;	<p>The Samsung smartphone incorporates into the housing a module that is responsive to intensity of the electromagnetic radiation in a selected spectral range.</p> <p>For example, the IR camera/sensor of the smartphone is responsive to electromagnetic radiation in the infrared range and is enclosed in the smartphone's housing.</p> <p>For example, the Galaxy S4 and Note 3 models have an IR sensor, which is a smartphone/tablet module that is capable of measuring the magnitude of electromagnetic radiation in the infrared range.</p>																				

Smartphones with thermometers do exist

The idea is nothing new and manufacturers in their constant pursuit of innovation did give it a try. Namely, Samsung and Motorola had phones with thermometers once.

Samsung did it with the Galaxy S4 and Note 3. According to the instructions for using this feature, measuring the temperature required you to leave the device to cool off from any heat it might have accumulated during use and leave it somewhere so it doesn't get warm from your hands.

[1]

For example, the Galaxy S21 Plus smartphone includes an IR wide angle camera, which is a smartphone module that is capable of measuring the magnitude of electromagnetic radiation in the infrared range.



Samsung Galaxy S21 Plus - Wide Camera Modified for Near Infrared Sensitivity

[2]

For example, the IR camera of the Galaxy S8, S8+, S9, S9+ and Note 8 models is used for the Iris Scan feature, whereby the IR camera measures the magnitude of electromagnetic radiation in the infrared range that is reflected by a user's eyes to distinguish unique characteristics of the user's eyes.

Why do we use IR(Infrared Ray)? or Iris Scan in Samsung Galaxy S8+?

Last Update date : Oct 30. 2020

In the case of visible ray, Iris pattern can be easily interfered by the reflection from other stray visible light **UV light** is strong enough to sterilize so that it may ingenerate skin aging. For those reasons, iris scan technology uses safer IR.



[3]

	<p>With Iris Scanning, your Samsung Galaxy illuminates your eyes with an IR-LED and snaps an IR photograph. Then, your phone looks at the details of your eyes and compares them to previous pictures. If the phone can verify who you are, then it unlocks.</p>  <p><small>© Hadrian/Shutterstock</small></p>
positioning the housing in a vicinity of the selected location;	<p>[4] As directed by marketing and operational instructions, a user of the Samsung smartphone positioning the housing in a vicinity of the selected location when using the Iris Scan feature or the IR camera.</p> <p>For example, an end user or Samsung test engineer, positions the smartphone such that it is in the vicinity of an external surface emitting infrared radiation in order to take a temperature reading, or in the vicinity of a subject and pointed thereat to take an IR wide angle image of the subject, or in the vicinity of a user and pointed at the user's eyes to use the Iris Scan feature, as the case may be for a given smartphone model.</p>

For example, the Galaxy S4 and Note 3 models have an IR sensor. To take a temperature reading, the S4 or Note 3 tablet needs to be placed in the vicinity of infrared electromagnetic radiation from an external source.

Smartphones with thermometers do exist

The idea is nothing new and manufacturers in their constant pursuit of innovation did give it a try. Namely, Samsung and Motorola had phones with thermometers once. Samsung did it with the Galaxy S4 and Note 3. According to the instructions for using this feature, measuring the temperature required you to leave the device to cool off from any heat it might have accumulated during use and leave it somewhere so it doesn't get warm from your hands.

[1]

For example, the Galaxy S21 Plus smartphone includes an IR camera. In order to take an IR photo of a subject, the smartphone needs to be positioned so that the IR camera is in the vicinity of the subject and pointed at the subject.



Samsung Galaxy S21 Plus - Wide Camera Modified for Near Infrared Sensitivity
[2]

For example, the IR camera of the Galaxy S8, S8+, S9, S9+ and Note 8 models is used for the Iris Scan feature. In order to use the Iris Scan feature, the smartphone needs to be positioned in the vicinity of the user's face with the IR camera pointed at the user's eyes.

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© Hadrian/Shutterstock

[4]

generating by the module a signal representative of the electromagnetic radiation;

The module of the Samsung smartphone generates a signal representative of the electromagnetic radiation.

For example, the IR camera/sensor generates a signal responsive to the infrared electromagnetic radiation received from the location or subject at which the IR camera is pointed, or from the vicinity in which the smartphone is placed.

For example the IR sensor in the Galaxy S4 and Note 3 models produces a signal that is used by the SoC processor to provide a numeric temperature

reading to the user via the display. The temperature reading is representative of the infrared electromagnetic radiation received by the IR sensor.

Smartphones with thermometers do exist

The idea is nothing new and manufacturers in their constant pursuit of innovation did give it a try. Namely, Samsung and Motorola had phones with thermometers once. Samsung did it with the Galaxy S4 and Note 3. According to the instructions for using this feature, measuring the temperature required you to leave the device to cool off from any heat it might have accumulated during use and leave it somewhere so it doesn't get warm from your hands.

[1]

For example the IR camera in the Galaxy S21 Plus model generates an IR image signal that is representative of the infrared electromagnetic radiation, e.g. hotter objects appear brighter in the image, which enables a user to distinguish hot objects from colder objects, bare earth from vegetation etc.



Samsung Galaxy S21 Plus - Wide Camera Modified for Near Infrared Sensitivity
[2]

For example, the IR camera of the Galaxy S8, S8+, S9, S9+ and Note 8 models used for the Iris Scan feature generates an image signal responsive to the infrared electromagnetic radiation received from the user's iris.

IR Scanning is Very Simple

Iris Scanner and Face ID are forms of biometric identification, and they're both used to unlock your phone and to open sensitive apps (banking apps, for example). Both processes are similar and easy to understand. New Apple and Samsung's phones are equipped with an IR-LED that emits near IR light, and an IR camera that is capable of capturing IR light.

With Iris Scanning, your Samsung Galaxy illuminates your eyes with an IR-LED and snaps an IR photograph. Then, your phone looks at the details of your eyes and compares them to previous pictures. If the phone can verify who you are, then it unlocks.



© Hadrian/Shutterstock

[4]

processing said signal to extract information

The Samsung smartphone processes the signal to extract information related to intensity of the electromagnetic radiation in the selected location.

<p>related to intensity of the electromagnetic radiation in the selected location, and</p>	<p>For example, the main processor in the SoC device processes the signal to extract information of the infrared electromagnetic radiation, in the location of the IR sensor or at which the IR camera is pointed in the case of the IR wide angle camera and Iris Scan feature.</p> <p>For example the IR sensor in the Galaxy S4 and Note 3 models produces a signal that is used by the SoC processor to provide a numeric temperature reading to the user via the display.[1]</p> <p>For example the IR camera in the Galaxy S21 Plus model generates an IR image signal that is representative of the infrared electromagnetic radiation and provides the image to the user on the display of the smartphone. [2]</p> <p>For example, the IR camera of the Galaxy S8, S8+, S9, S9+ and Note 8 models used for the Iris Scan feature generates an image signal responsive to the infrared radiation received from the user's iris. The SoC device processes the signal to extract information, based in part on the intensity of the received infrared electromagnetic radiation, to determine characteristics of the user's iris. If the characteristics sufficiently match previously recorded characteristics, the SoC unlocks the smartphone. [3] [4] [5]</p>
<p>sending said information to the output means for conveying the information to the operator.</p>	<p>The Samsung smartphone sends the information to the output means for conveying the information to the operator.</p> <p>For example, depending on the feature being activated, the SoC processor sends the information to the touchscreen display, which causes the display to be unlocked as in the case of the Iris Scan feature, or to display a temperature, or to display an IR image captured with the IR camera. [1] [2] [3] [4] [5]</p>

Product List:

Smartphones with IR cameras: Galaxy S4 and Note3 smartphones

Smartphones with wide camera having near IR sensitivity: Galaxy S21 Plus smartphone

Smartphones with the Iris Scan feature: Galaxy S8, S8+, S9, S9+ and Note 8 smartphones/tablets

References:

[1] Galaxy S4 and Note3 smartphones

https://www.phonearena.com/news/can-smartphone-take-temperature_id121600

[2] Galaxy S21 Plus smartphone

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video at 0:08

[3] Galaxy S8, S8+, S9, S9+ and Note 8 smartphones/tablets

<https://www.samsung.com/in/support/mobile-devices/why-do-we-use-ir-infrared-ray-for-iris-scan-in-samsung-galaxy-s8-plus/>

[4] Galaxy S8, S8+, S9, S9+ and Note 8 smartphones

<https://www.howtogeek.com/404731/are-ir-scanners-in-phones-bad-for-your-eyes/>

[5] Galaxy S8, S8+, S9, S9+ and Note 8 smartphones

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